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SEATBELT FORCE SENSOR ASSEMBLY WITH GUIDE MEMBER

RELATED APPLICATION

[1] This application claims priority to provisional application 60/236,458 filed on September 29, 2000 and is a continuation in part of application number 09/853,338 filed on May 11, 2001.

BACKGROUND OF THE INVENTION

[2] Field of the Invention.

This invention relates to a method and apparatus for measuring the force applied to a seat belt. Specifically, a sensor arrangement is mounted on a rigid plate secured between a seatbelt portion and a vehicle structure and includes a guide member for guiding the seatbelt portion to isolate the sensor from input forces applied at an angle to the seatbelt portion, which increases the accuracy of the seatbelt force measurements.

[3] Related Art.

Most vehicles include airbags and seatbelt restraint systems that work together to protect the driver and passengers from experiencing serious injuries due to high-speed collisions. It is important to control the deployment force of the airbags based on the size of the driver or the passenger. When an adult is seated on the vehicle seat, the airbag should be deployed in a normal manner. If there is an infant seat or small adult/child secured to the vehicle seat then the airbag should not be deployed or should be deployed at

a significantly lower deployment force. One way to control the airbag deployment is to monitor the weight of the seat occupant.

[4] Current systems for measuring the weight of a seat occupant are complex and expensive. One type of system uses pressure sensitive foil mats mounted within the seat bottom foam. Another system uses sensors placed at a plurality of locations within the seat bottom. The combined output from the mats or the sensors is used to determine the weight of the seat occupant. The accuracy of the weight measurements from these types of sensor systems can be compromised due to additional seat forces resulting from the occupant being secured to the seat with a seatbelt.

[5] For example, weight sensor systems can have difficulty identifying an adult, a child, or a car seat when the seatbelt is being used. When a child seat is secured to a seat with a seatbelt, an excess force acts on the sensors mounted within the rear portion of the seat bottom, which interferes with accurate weight sensing. Over tightening of the seatbelt to securely hold the child seat in place, pulls the child seat down against the rear part of the seat bottom, causing the excessive force measured by the sensors. Due to this effect, the current weight sensing systems have difficulty in discerning between an adult belted to a seat and a child seat secured to the seat with a seatbelt.

[6] In order to address this problem, sensors have been incorporated into the seatbelt to measure the tension force applied to the seatbelt as passengers or a child seat is secured to the seat. High seatbelt tension forces indicate that a child seat is secured to the seat. One type of seatbelt force sensor is mounted on a rigid plate member having one end attached to a seatbelt portion. The sensor measures strain applied to the plate via the seatbelt. This type of sensor provides accurate measurements for input loads that are applied linear or

axial direction. However, if the seatbelt is pulled or tightened at an undesirable angle, the sensor can provide less accurate measurements.

[7] Thus, it is desirable to have a system for measuring seatbelt forces to determine whether a child seat or an adult is secured to the seat that utilizes a sensor that is isolated from non-axial movements, and which provides increased accuracy for seatbelt force measurements. The system should also work with traditional seat occupant weight sensing systems and be easy to install, as well as overcoming any other of the above referenced deficiencies with prior art systems.

SUMMARY OF THE INVENTION

A system for measuring seatbelt forces includes a rigid plate member that supports a seatbelt force sensor and a guide member for isolating the sensor from input forces applied to the seatbelt at undesirable angles. The method of measuring the seatbelt force includes the following steps. One end of the rigid plate member is mounted to a seatbelt portion and an opposite end of the rigid plate member is mounted to a vehicle structure. An input force is applied to the seatbelt portion. The seatbelt portion is guided by a guide member to isolate the seatbelt force sensor from input forces applied at an angle. The seatbelt force sensor generates an output signal that is representative of the force applied to the seatbelt portion. Preferably, the guide member is pivotally mounted at one end between the rigid plate member and the vehicle structure.

In a disclosed embodiment of this invention, the sensor assembly includes a rigid member having one end operably coupled to a seatbelt portion and a sensor mounted on the rigid member for measuring strain exerted on the rigid member by an input force applied to

the seatbelt portion. The assembly further includes a bracket having a first mounting portion for attachment to the rigid member and a second mounting portion for attachment to a vehicle structure, such as a B-pillar, anchor side mount, or buckle side mount. This bracket defines a guide for isolating the sensor from non-axial input forces applied to the seatbelt portion. Preferably the first mounting portion is parallel to the rigid member and the second mounting portion is transverse to the rigid member.

In a disclosed embodiment, the second mounting portion includes a pair of bosses mounted on opposing sides of the bracket. Each of the bosses includes an aperture for supporting a pivot shaft. The bracket pivots about a pivot axis defined by the pivot shaft and relative to the vehicle structure. This configuration provides a guide for the seatbelt to eliminate angle effects on the sensor.

[8] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[9] Figure 1 is a schematic view showing a vehicle with an airbag system and an occupant sitting in a seat with the airbag in an active state shown in dashed lines.

[10] Figure 2 is a schematic side view of a seat assembly with an infant car seat secured to the vehicle seat.

[11] Figure 3 is a schematic front view of a seat and seatbelt assembly.

[12] Figure 4 is an overhead view of subject sensor assembly.

[13] Figure 5 is a side view of the sensor of Figure 4.

[14] Figure 6 is schematic diagram of the control system.

[15] Figure 7 is a perspective view of an alternate embodiment of the sensor assembly.

[16] Figure 8 is a side cross-sectional view of the sensor assembly mounted to a B-pillar.

[17] Figure 9 is a perspective view of the sensor assembly of Figure 8.

[18] Figure 10 is a perspective view, partially cut-away, of the sensor assembly mounted in a seat latch mechanism.

[19] Figure 11 is a perspective view of the bracket of Figures 8 and 9.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

[20] A vehicle includes a vehicle seat assembly, shown generally at 12 in Figure 1, and an airbag system 14. The seat assembly 12 is preferably a passenger seat and includes a seat back 16 and a seat bottom 18. A vehicle occupant 20 is secured to the seat 12 with a seatbelt 22. A tension force F_T is exerted on the seatbelt 22. The tension force F_T represents the force is exerted against the occupant as the belt is tightened.

[21] The airbag system 14 deploys an airbag 24 under certain collision conditions. The deployment force for the airbag 24, shown as deployed in dashed lines in Figure 1, varies depending upon the type of occupant that is belted to the seat 12. When an adult 20 is belted to the vehicle seat 12, the airbag 24 should be deployed in a normal manner shown in Figure 1. If there is an infant or child seat 26 secured to the vehicle seat 12, see Figure 2, then the airbag 24 should not be deployed. Thus, it is important to be able to determine whether there is an adult 20 belted to the seat 12 or whether an infant seat 26 is secured to the seat with a seatbelt 22. One way to determine this is by monitoring the tension exerted on the seatbelt 22. When an adult 20 is belted to the seat, normal seatbelt forces are exerted against the seatbelt 22. When an infant or child seat 26 is belted to the

seat 12, high tension forces are exerted on the seatbelt 22 because the seatbelt 22 is overtightened to securely hold the child seat 26 in place.

[22] The seatbelt 22, shown more clearly in Figure 3, has a strap portion 28 that includes a shoulder harness and/or lap belt that is connected to a male buckle member 30. A seatbelt latch mechanism 32 is hard mounted to the seat 12 and typically extends outwardly from the seat 12 between the seat back 16 and the seat bottom 18. The latch mechanism 32 includes a female receptacle 34 that receives the male buckle member 30 to secure the occupant 20 or child seat 26 to the seat 12. The strap portion 28 can be manually or automatically tightened once the belt is buckled to a desired tension.

[23] A sensor assembly 40 for measuring the tension forces in the seatbelt 22 is shown in Figures 4 and 5. The sensor assembly 40 includes a rigid member that is preferably formed as a metallic plate 42 from 4130Rc39 material, however, other similar materials could also be used. The plate 42 includes a first end 44 that is attached via a loop connection 46 to material that forms a portion of the seatbelt 22 and a second end 48 that is attached to a vehicle structure. The vehicle structure attachment will be discussed in greater detail below.

[24] The plate 42 is defined by a length "l", a width "w", and a thickness "t". In the preferred embodiment, the length l is greater than the width w and the thickness t is significantly less than the width w and the length l. The plate 42 includes a necked portion 50 positioned between the ends 44, 48 that is narrower than the ends 44, 48. A strain gage 52 is mounted on the necked portion 50. The tightening of the seatbelt 22 exerts a tension force F_T on the plate 42 via the looped connection 46, which results in

strain on the necked portion 50. The strain gage 52 measures this strain. The strain gage 52 is preferably a full bridge strain gage with four (4) grids.

[25] The first end 44 of the plate 42 is preferably positioned at an angle relative to the necked portion 50 and the second end 48. This causes the tension force to be applied at an angle, which creates a moment M_T at one edge of the necked portion 50. The second end 48 of the plate 42 is hard mounted to a vehicle structure creating a reaction force F_{rea} and moment M_{rea}. The strain gage 52 measures the strain resulting in the necked portion 50 of the plate 42 as the tension force F_T is applied to the first end 44 of the plate 42.

[26] An electrical connector 54 is also mounted on the plate 42 adjacent to the strain gage 52. The strain measurements are generated as signals 56 that are sent from the gage 52 to the connector 54 and then to an electronic control unit (ECU) or microprocessor 58, see Figure 6. The ECU 58 can be incorporated into the connector 54 to include the necessary electronics and printed circuit board (as shown in Figure 4) or can be a separate component at a remote location on the vehicle. The ECU 58 processes the strain signals 56 to determine the magnitude of the tension forces F_T exerted on the seatbelt 22 and sends a control signal 66 to a central electronic control unit (ECU) or central microprocessor 60 to control deployment of the airbag 24. It should be understood that the ECU 58 and the central ECU 60 could be separate units or could be the same unit. An optional configuration for an electrical connector 62 is shown in Figure 7. This configuration includes a simplified wire connection 64 to the ECU 58 and/or 60.

[27] As discussed above, the plate 42 is hard mounted to a vehicle structure. The vehicle structure can be a B-pillar 68 as shown in Figures 8 and 9 or the seat latch mechanism 32 as shown in Figure 10. The B-pillar 68 extends vertically to one side of

the vehicle and is typically positioned adjacent to the seat 12 and behind a front passenger door of the vehicle. For a side mount, such as the B-pillar, side anchor, or side buckle mount a secondary metal plate or bracket 70 is included to provide a guide for the seatbelt 22. The bracket 70 includes at least one circular boss 72 for receiving a pivot pin 74 at one end 76. Preferably, a pair of bosses 72 are mounted on opposite sides of the bracket, which include openings 90 for receiving the pivot pin 74. One end 78 of the secondary metal plate 70 includes an opening 96 that is overlaid and aligned with opening 82 of the rigid metal plate 42 to receive at least one fastener 80. The one mounting portion end 78 of the bracket 70 is preferably parallel to the rigid metal plate 42 while the other mounting portion including the bosses 72 is preferably non-parallel or transverse to the rigid metal plate 42.

[28] The bracket 70 pivots about an axis 92 defined by the openings 90 and the pivot shaft 74 relative to the vehicle structure. The rigid metal plate 42 defines an axial input load force axis 94 (see Fig. 4) and the pivot axis 92 is transverse to this axial input load force axis 94. This configuration provides a guide for the seatbelt 22 and eliminates adverse effects on the strain gage 52 due to loads applied at undesirable angles to the seatbelt 22.

[29] The seat latch mechanism mount is shown in Figure 10. The second end 48 of the plate 42 includes at least one aperture 82 for receiving a fastener 84 to hard mount the plate 42 to the seat. The opposite end 44 of the plate 42 has an elongated slot 86 for connecting the plate 42 to the looped material, which extends to the female receptacle 34 having a slot 88 for receiving the buckle member 30.

[30] In both configurations, the strain gage 52 measure the strain caused by the tension force F_T in the seatbelt 22. The airbag deployment is controlled based upon the strain measurements and the airbag 24 is not deployed if the tension force F_T exceeds a predetermined limit. An adult can experience a tension force in a seatbelt up to approximately 30 pounds (lbs) and still be comfortable. If the strain gage 52 measures a tension force F_T that exceeds 30 lbs than that would indicate that a child seat 26 has been belted to the seat 12. Thus, the airbag 24 would not be deployed during a collision under these conditions. It should be understood that 30 lbs is an approximate value, which can vary due to differing seat and seatbelt configurations. Thus, the predetermined limit for comparison to the measured tension force F_T can also vary depending upon the seat configuration.

The bracket 70 is shown in greater detail in Figure 11. The bracket 70 includes a generally flat body portion 100 that is defined by a first end 102, a second end 104, a first side 106 interconnecting the first 102 and second 104 ends to define a first edge 108, and a second side 110 interconnecting the first 102 and second 104 ends to define a second edge 112 opposite from the first edge 108. The boss portions 72 each extend outwardly along a portion of the first 108 and second 112 edges. The boss portions 72 with aligned openings 90 support the pivot shaft 74 at the second end 104 and the body portion 100 is attached to the rigid metal plate 42 at the first end 102.

[31] The subject sensing system provides simplified and efficient apparatus and method for determining whether conditions are proper for deploying an airbag 24 by measuring seatbelt forces to discern whether a child in a child seat 26 or an adult is belted to the seat 12. The system provides accurate measurements and is easy to install.

[32] Although a preferred embodiment of this invention has been disclosed, it should be understood that a worker of ordinary skill in the art would recognize many modifications come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.